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ABSTRACT

Activities and teaching methods for developing an understanding of fractions are presented. The activities, which use mathematical models (visual representations of fractions), are divided into three sections: (1) equivalent fraction circles; (2) fraction bars; and (3) multiplication of fractional numbers using squares. Each section includes the purpose (concept or concepts to be taught), materials needed (transparencies and handouts), directions for making the materials, photocopied transparency and handout masters, and teaching procedures for the activities. (DC)

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SEEING Through FRACTIONS

Methods for Teaching Fractions
with Emphasis on Equivalency
and Multiplication
(Grades 3 - 6)

SE041792

DES MOINES INDEPENDENT SCHOOL DISTRICT

1800 Grand Avenue

Des Moines, Iowa 50307

"SEEING THROUGH FRACTIONS"

Ann Vandehaar
Gail Reed

Adapted with permission.
Workshop by Marilyn Zweng
NCTM Annual meeting, 1979

Methods for teaching fractions with emphasis on equivalency and multiplication using models. (Intermediate Grades)

Title I Elementary Mathematics Program

1979

Equivalent Fraction Circles

Purpose: To provide experiences with equivalent fractions which are less than or equal to one.

Materials: Transparencies (Xerox patterns provided)

Directions for Making:

Thermofax transparencies. Run transparencies through thermofax machine using Xerox patterns provided as masters. Use Xerox patterns also for fraction worksheets.

Teaching Procedure:

The equivalent fraction circles may be used with either teacher developed or textbook exercises to introduce or reinforce the concept that a fractional number has many different names. For class activities have students color, for example, $\frac{1}{3}$ of the third circle on their worksheet. Ask them to find portions of the transparency circles that match the colored $\frac{1}{3}$ ($\frac{2}{6}$, $\frac{3}{9}$, $\frac{4}{12}$). Repeat with $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$, $\frac{2}{3}$, etc.

1. Color $\frac{1}{3}$ of the thirds circle on your worksheet.

   Put other transparency circles over the thirds circle to answer the questions.

   a. How many $\frac{1}{6}$'s match $\frac{1}{3}$? ___ $\frac{1}{3} = \frac{___}{6}$

   b. How many $\frac{1}{9}$'s match $\frac{1}{3}$? ___ $\frac{1}{3} = \frac{___}{9}$

   c. How many $\frac{1}{12}$'s match $\frac{1}{3}$? ___ $\frac{1}{3} = \frac{___}{12}$

2. Color another $\frac{1}{3}$ of the thirds circle. $\frac{2}{3}$ of the circle will be colored. Use the transparency circles to answer the questions.

   a. How many $\frac{1}{6}$'s match $\frac{2}{3}$? ___ $\frac{2}{3} = \frac{___}{6}$

b. How many $\frac{1}{9}$'s match $\frac{2}{3}$? ____ $\frac{2}{3} = \frac{\quad}{9}$

c. How many $\frac{1}{12}$'s match $\frac{2}{3}$? ____ $\frac{2}{3} = \frac{\quad}{12}$

3. Color $\frac{1}{2}$ of the halves circle and use your transparency circles.

a. How many $\frac{1}{4}$'s match $\frac{1}{2}$? ____ $\frac{1}{2} = \frac{\quad}{4}$

b. How many $\frac{1}{6}$'s match $\frac{1}{2}$? ____ $\frac{1}{2} = \frac{\quad}{6}$

c. How many $\frac{1}{12}$'s match $\frac{1}{2}$? ____ $\frac{1}{2} = \frac{\quad}{12}$

d. How many $\frac{1}{10}$'s match $\frac{1}{2}$? ____ $\frac{1}{2} = \frac{\quad}{10}$

e. How many $\frac{1}{8}$'s match $\frac{1}{2}$? ____ $\frac{1}{2} = \frac{\quad}{8}$

4. Color $\frac{1}{4}$ of the fourths circle and use your transparency circles to answer these questions.

a. How many $\frac{1}{8}$'s match $\frac{1}{4}$? ____ $\frac{1}{4} = \frac{\quad}{8}$

b. How many $\frac{1}{12}$'s match $\frac{1}{4}$? ____ $\frac{1}{4} = \frac{\quad}{12}$

c. How many $\frac{1}{16}$'s match $\frac{1}{4}$? ____ $\frac{1}{4} = \frac{\quad}{16}$

5. Color two more $\frac{1}{4}$'s on the fourths circle. $\frac{3}{4}$ of the circle will be colored.

a. How many $\frac{1}{8}$'s match $\frac{3}{4}$? ____ $\frac{3}{4} = \frac{\quad}{8}$

b. How many $\frac{1}{12}$'s match $\frac{3}{4}$? ____ $\frac{3}{4} = \frac{\quad}{12}$

c. How many $\frac{1}{16}$'s match $\frac{3}{4}$? ____ $\frac{3}{4} = \frac{\quad}{16}$

6. Color the remaining section on the fourths circle. $\frac{4}{4}$ of the circle will be colored.

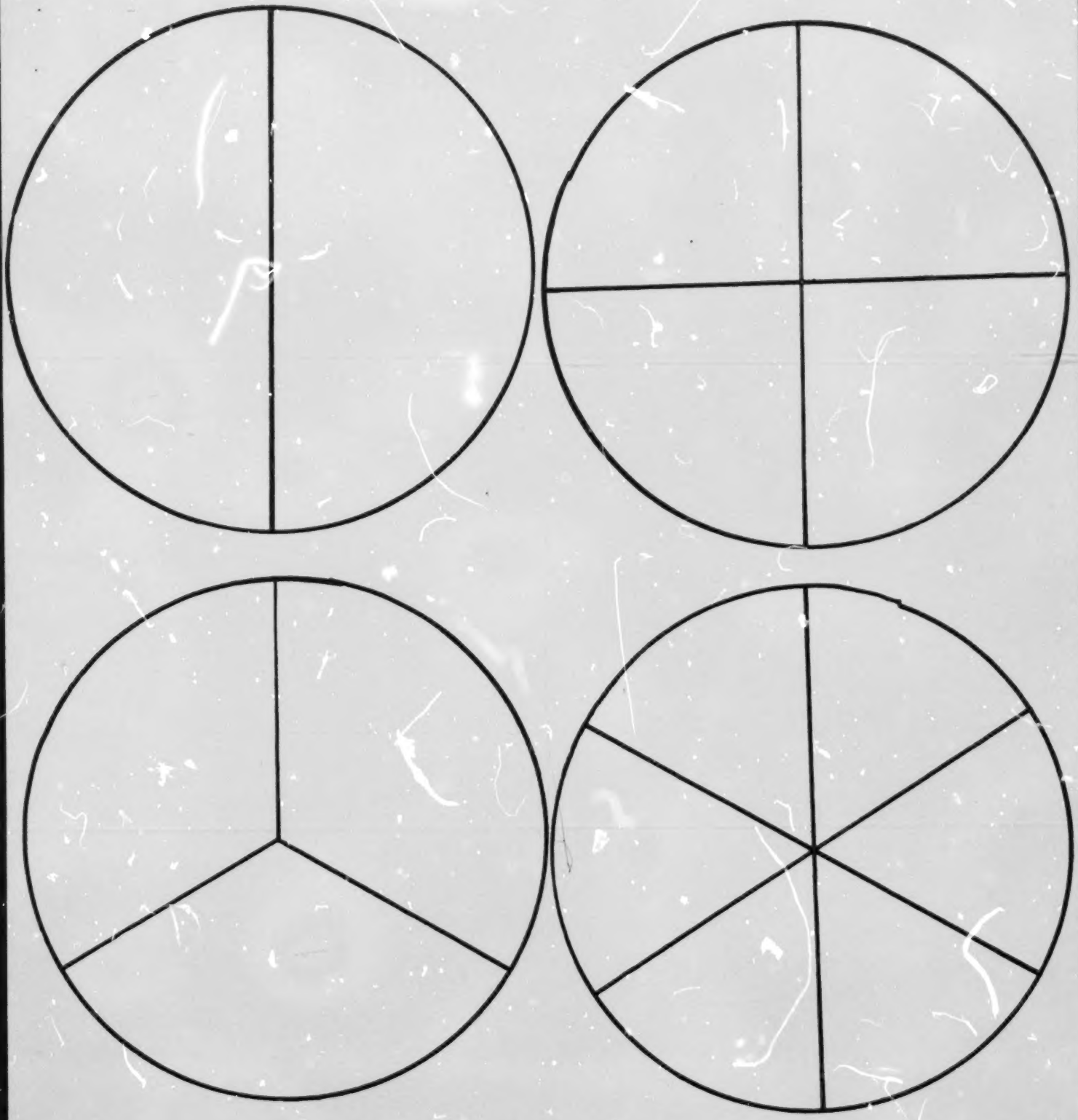
a. How many $\frac{1}{8}$'s match $\frac{4}{4}$? ____ $\frac{4}{4} = \frac{\quad}{8}$

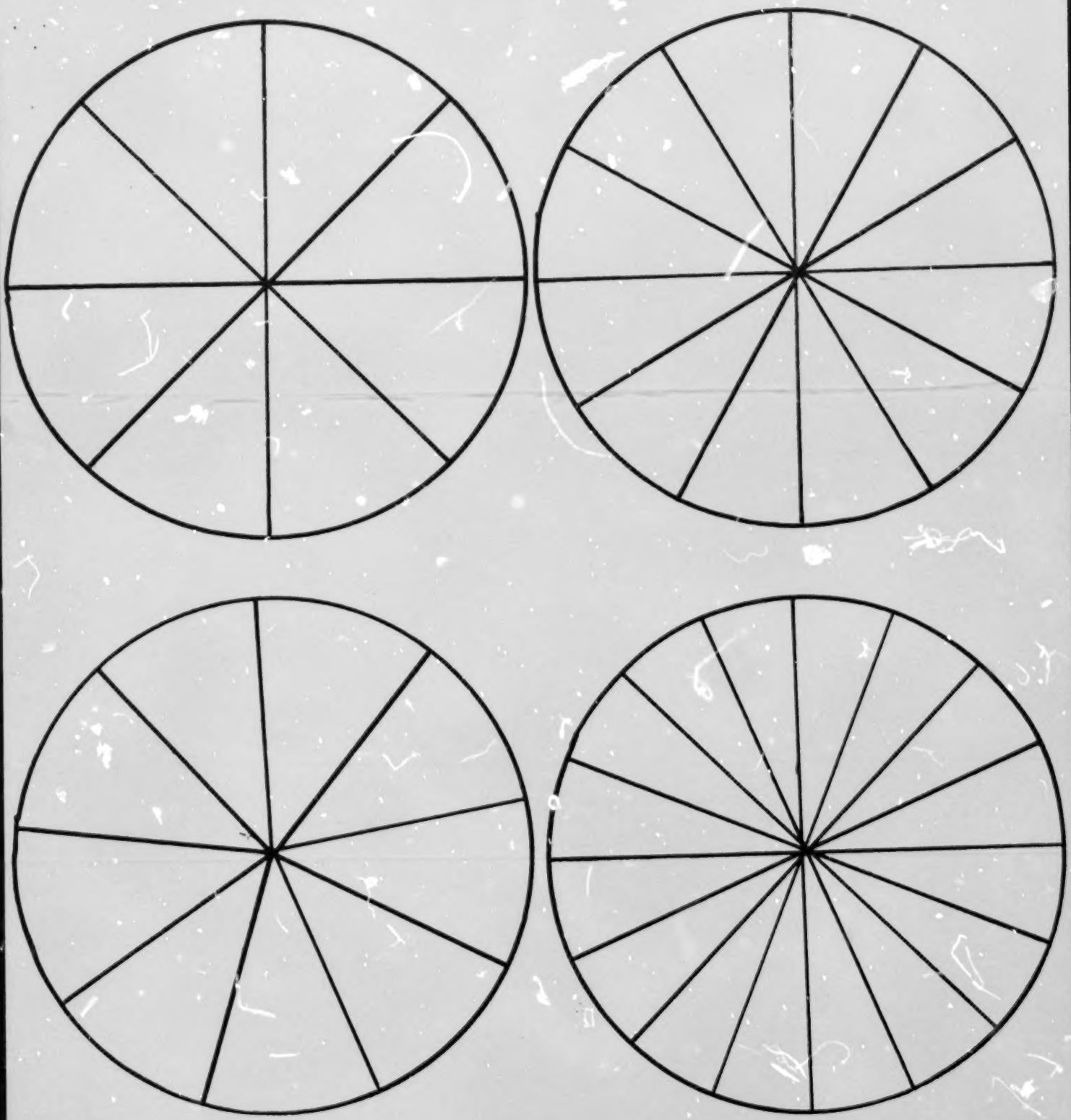
b. How many $\frac{1}{6}$'s match $\frac{4}{4}$? ____ $\frac{4}{4} = \frac{\quad}{6}$

c. How many $\frac{1}{9}$'s match $\frac{4}{4}$? ____ $\frac{4}{4} = \frac{\quad}{9}$

d. How many $\frac{1}{12}$'s match $\frac{4}{4}$? ____ $\frac{4}{4} = \frac{\quad}{12}$

etc.





FRACTION BARS

Purposes:

(1) To establish the meaning of $\frac{a}{b}$. For example, the bars demonstrate that $\frac{3}{4}$ means $3 \times \frac{1}{4}$, $\frac{7}{8}$ means $7 \times \frac{1}{8}$, $\frac{9}{4}$ means $9 \times \frac{1}{4}$, etc.

(2) To provide experiences from which children will devise rules for generating equivalent fractions with numbers less than one and numbers greater than one.

(3) To establish that $\frac{2}{2}$, $\frac{3}{3}$, $\frac{4}{4}$, ... are all names for 1; $\frac{4}{2}$, $\frac{6}{3}$, $\frac{8}{4}$, ... are all names for 2; and $\frac{6}{2}$, $\frac{9}{3}$, $\frac{12}{4}$, ... are all names for 3.

(4) To compare fractions to find which is greater or less $\frac{5}{4} > \frac{2}{3}$, $\frac{1}{6} < \frac{1}{3}$.

(5) To provide students with experiences which will help them develop procedures for renaming mixed numerals as improper fractions and vice versa.

Materials: (For 5 Sets of Fraction Bars)

3 pieces of oak tag (different colors)

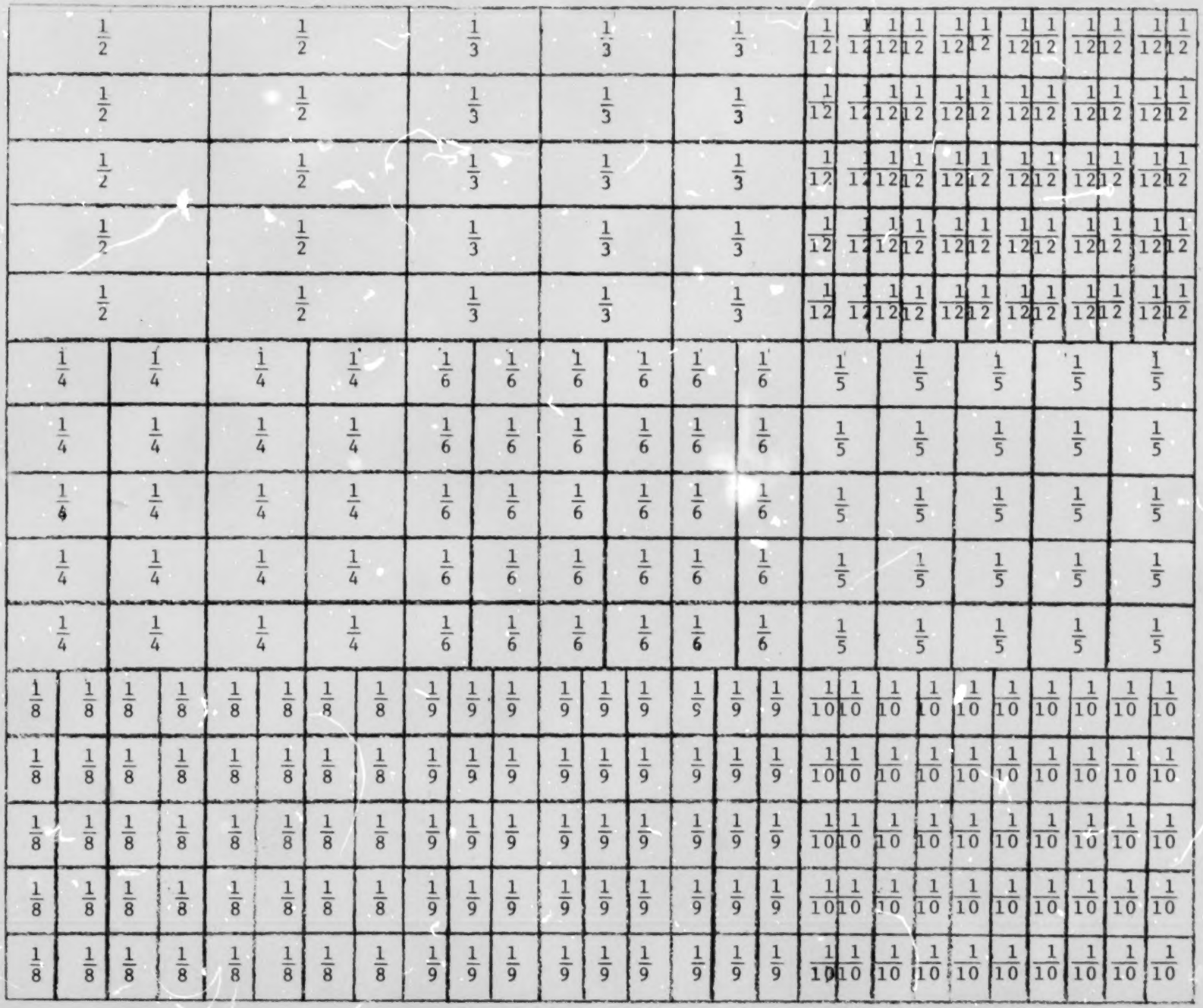
5 pieces of oak tag

Thermofax masters (Xerox patterns for fraction bars, fraction track, and worksheets provided)

Laminating material

Directions for Making:

Make Xerox patterns into ditto masters. For five sets of bars, feed each piece of different colored oak tag through duplicating machine. Laminate materials if desired. Cut so each student will have three of each bar, each a different color (for example; 3, $\frac{1}{8}$'s bars, one green, one red, one blue). Run five fraction tracks on oak tag. The fraction track can also be produced on ditto paper.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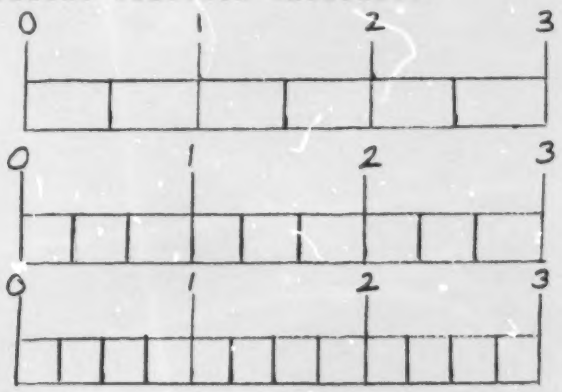
FRACTION TRACK

Teaching Procedure:

The fraction track just described is particularly useful with exercises involving renaming mixed numerals as improper fractions and renaming improper fractions as mixed numerals.

When working with exercises on equivalent fractions, no fraction track is needed. The only materials needed for any "equivalent fractions" exercise are two bars. For example, to solve: $\frac{4}{3} = \frac{\quad}{9}$, a thirds bar and ninths bar are used.

An alternate version of the fraction track to use for equivalent fractions is as follows. Make three fraction tracks, one divided into halves, one into thirds, and one into fourths. Write numerals "1", "2", and "3" above each bar at appropriate points. Leave work space between the bars. With these fraction tracks the student usually has to hunt for only one fraction bar in order to work an equivalent fraction exercise.



See sample exercises for these activities:

(1) Renaming fractions (from smaller to larger denominator)
(2) Renaming fractions (from larger to smaller denominator)
(3) Many names for the same number
(4) Lowest term fractions
(5) Renaming improper fractions with mixed numerals
(6) Renaming mixed numerals with improper fractions

EQUIVALENT FRACTIONS
(from smaller to larger denominator)

1. Match the $\frac{1}{8}$'s bar to the $\frac{1}{2}$'s bar to name the equivalent fractions.

   a. $\frac{1}{2} = \frac{\square}{8}$ b. $\frac{3}{2} = \frac{\square}{8}$ c. $\frac{5}{2} = \frac{\square}{8}$ d. $\frac{2}{2} = \frac{\square}{8}$

2. Match the $\frac{1}{8}$'s bar to the $\frac{1}{4}$'s bar to name the equivalent fractions.

   a. $\frac{1}{4} = \frac{\square}{8}$ b. $\frac{3}{4} = \frac{\square}{8}$ c. $\frac{9}{4} = \frac{\square}{8}$ d. $\frac{11}{4} = \frac{\square}{8}$

3. Match the $\frac{1}{6}$'s bar to the $\frac{1}{2}$'s bar to name the equivalent fractions.

   a. $\frac{1}{2} = \frac{\square}{6}$ b. $\frac{3}{2} = \frac{\square}{6}$ c. $\frac{5}{2} = \frac{\square}{6}$ d. $\frac{4}{2} = \frac{\square}{6}$

4. Match the $\frac{1}{6}$'s bar to the $\frac{1}{3}$'s bar to name the equivalent fractions.

   a. $\frac{1}{3} = \frac{\square}{6}$ b. $\frac{2}{3} = \frac{\square}{6}$ c. $\frac{4}{3} = \frac{\square}{6}$ d. $\frac{8}{3} = \frac{\square}{6}$

5. Match the $\frac{1}{9}$'s bar to the $\frac{1}{3}$'s bar to name the equivalent fractions.

   a. $\frac{1}{3} = \frac{\square}{9}$ b. $\frac{2}{3} = \frac{\square}{9}$ c. $\frac{5}{3} = \frac{\square}{9}$ d. $\frac{7}{3} = \frac{\square}{9}$

6. Match the $\frac{1}{10}$'s bar to the $\frac{1}{2}$'s bar to name the equivalent fractions.

   a. $\frac{1}{2} = \frac{\square}{10}$ b. $\frac{3}{2} = \frac{\square}{10}$ c. $\frac{5}{2} = \frac{\square}{10}$ d. $\frac{4}{2} = \frac{\square}{10}$

EQUIVALENT FRACTIONS
(from smaller to larger denominator, continued)

1. Match the $\frac{1}{12}$'s bar to the $\frac{1}{2}$'s bar to name the equivalent fractions.

   a. $\frac{1}{2} = \frac{\square}{12}$ b. $\frac{5}{2} = \frac{\square}{12}$ c. $\frac{4}{2} = \frac{\square}{12}$ d. $\frac{3}{2} = \frac{\square}{12}$

2. Match the $\frac{1}{12}$'s bar to the $\frac{1}{3}$'s bar to name the equivalent fractions.

   a. $\frac{1}{3} = \frac{\square}{12}$ b. $\frac{4}{3} = \frac{\square}{12}$ c. $\frac{2}{3} = \frac{\square}{12}$ d. $\frac{7}{3} = \frac{\square}{12}$

3. Match the $\frac{1}{12}$'s bar to the $\frac{1}{4}$'s bar to name the equivalent fractions.

   a. $\frac{1}{4} = \frac{\square}{12}$ b. $\frac{3}{4} = \frac{\square}{12}$ c. $\frac{7}{4} = \frac{\square}{12}$ d. $\frac{9}{4} = \frac{\square}{12}$

4. Match the $\frac{1}{16}$'s bar to the $\frac{1}{2}$'s bar to name the equivalent fractions.

   a. $\frac{1}{2} = \frac{\square}{16}$ b. $\frac{3}{2} = \frac{\square}{16}$ c. $\frac{2}{2} = \frac{\square}{16}$ d. $\frac{5}{2} = \frac{\square}{16}$

5. Match the $\frac{1}{16}$'s bar to the $\frac{1}{4}$'s bar to name the equivalent fractions.

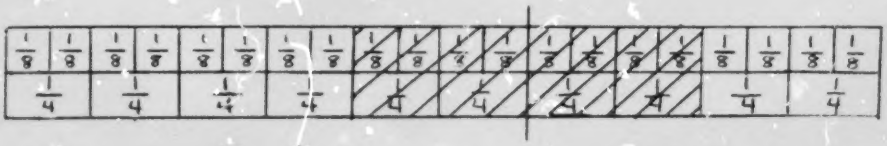
   a. $\frac{1}{4} = \frac{\square}{16}$ b. $\frac{3}{4} = \frac{\square}{16}$ c. $\frac{7}{4} = \frac{\square}{16}$ d. $\frac{5}{4} = \frac{\square}{16}$

6. Match the $\frac{1}{16}$'s bar to the $\frac{1}{8}$'s bar to name the equivalent fractions.

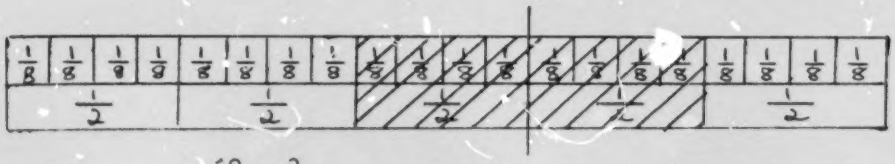
   a. $\frac{1}{8} = \frac{\square}{16}$ b. $\frac{3}{8} = \frac{\square}{16}$ c. $\frac{9}{8} = \frac{\square}{16}$ d. $\frac{2}{8} = \frac{\square}{16}$

EQUIVALENT FRACTIONS
(from larger to smaller denominator - "reducing")

To rename $\frac{12}{8}$ with a fraction that has a smaller denominator compare the $\frac{1}{8}$'s bar with the $\frac{1}{2}$'s bar and the $\frac{1}{4}$'s bar.



$$\frac{12}{8} = \frac{6}{4}$$



$$\frac{12}{8} = \frac{3}{2}$$

You will not always be able to rename eighths with halves. Sometimes you will not be able to rename eighths with either halves or fourths.

<u>Exercises</u>. There will be more than one correct answer for many of the exercises.

1. Match the $\frac{1}{8}$'s bar to $\frac{1}{2}$'s and $\frac{1}{4}$'s bars to name equivalent fractions.

   a. $\frac{6}{8} =$ b. $\frac{4}{8} =$ c. $\frac{14}{8} =$ d. $\frac{20}{8} =$

   e. $\frac{2}{8} =$ f. $\frac{10}{8} =$ g. $\frac{18}{8} =$ h. $\frac{16}{8} =$

2. Match the $\frac{1}{6}$'s bar to $\frac{1}{3}$ and $\frac{1}{2}$'s bars to name equivalent fractions.

   a. $\frac{3}{6} =$ b. $\frac{4}{6} =$ c. $\frac{8}{6} =$ d. $\frac{9}{6} =$

   e. $\frac{2}{6} =$ f. $\frac{8}{6} =$ g. $\frac{14}{6} =$ h. $\frac{15}{6} =$

3. Match the $\frac{1}{10}$'s bar to $\frac{1}{2}$'s and $\frac{1}{5}$'s bars to name equivalent fractions.

   a. $\frac{2}{10} =$ b. $\frac{5}{10} =$ c. $\frac{8}{10} =$ d. $\frac{15}{10} =$

   e. $\frac{12}{10} =$ f. $\frac{4}{10} =$ g. $\frac{18}{10} =$ h. $\frac{6}{10} =$

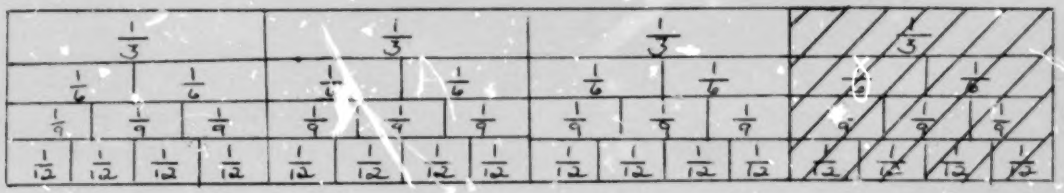
4. Match the $\frac{1}{12}$'s bar to $\frac{1}{2}$'s, $\frac{1}{3}$'s, and $\frac{1}{4}$'s bars to name equivalent fractions.

   a. $\frac{2}{12} =$ b. $\frac{4}{12} =$ c. $\frac{3}{12} =$ d. $\frac{6}{12} =$

   e. $\frac{9}{12} =$ f. $\frac{15}{12} =$ g. $\frac{18}{12} =$ h. $\frac{8}{12} =$

MANY NAMES FOR THE SAME NUMBER

The bars show that $\frac{2}{3}$, $\frac{4}{6}$, $\frac{6}{9}$, and $\frac{8}{12}$ name the same number.



Exercises

Use your fraction bars to list the equivalent fractions in the set.

1. $\left\{\frac{1}{3}, \frac{}{6}, \frac{}{9}, \frac{}{12}\right\}$

2. $\left\{\frac{1}{2}, \frac{}{4}, \frac{}{6}, \frac{}{8}, \frac{}{10}, \frac{}{12}\right\}$

3. $\left\{\frac{3}{4}, \frac{}{8}, \frac{}{12}, \frac{}{16}\right\}$

4. $\left\{\frac{4}{3}, \frac{}{6}, \frac{}{9}, \frac{}{12}\right\}$

5. $\left\{\frac{1}{4}, \frac{}{8}, \frac{}{12}, \frac{}{16}\right\}$

6. $\left\{\frac{5}{4}, \frac{}{8}, \frac{}{12}, \frac{}{16}\right\}$

7. $\left\{\frac{5}{2}, \frac{}{4}, \frac{}{6}, \frac{}{8}, \frac{}{10}, \frac{}{12}\right\}$

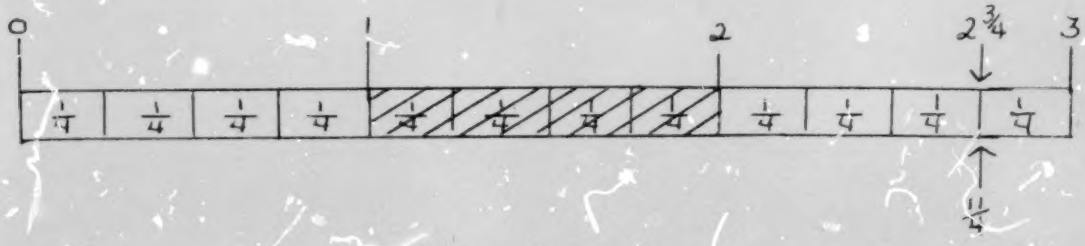
8. Find a fraction for 1 on each of your bars. List the fractions.

9. Find a fraction for 2 on each of your bars. List the fractions.

10. Find a fraction for 3 on each of your bars. List the fractions.

RENAMING IMPROPER FRACTIONS WITH MIXED NUMERALS

To rename $\frac{11}{4}$ with a mixed numeral, place the $\frac{1}{4}$'s bar on the fraction track.



The fraction track shows that $\frac{11}{4} = 2\frac{3}{4}$

<u>Exercises</u>: Place the indicated rod on the fraction track. Use the track to rename the improper fraction with a mixed numeral or a whole number.

1. $\frac{1}{3}$'s rod.

   a. $\frac{5}{3}$ = ____ b. $\frac{7}{3}$ = ____ c. $\frac{8}{3}$ = ____ d. $\frac{4}{3}$ = ____

2. $\frac{1}{4}$'s rod.

   a. $\frac{5}{4}$ = ____ b. $\frac{9}{4}$ = ____ c. $\frac{6}{4}$ = ____ d. $\frac{12}{4}$ = ____

3. $\frac{1}{8}$'s rod.

   a. $\frac{11}{8}$ = ____ b. $\frac{16}{8}$ = ____ c. $\frac{19}{8}$ = ____ d. $\frac{15}{8}$ = ____

4. $\frac{1}{10}$'s rod.

   a. $\frac{12}{10}$ = ____ b. $\frac{24}{10}$ = ____ c. $\frac{18}{10}$ = ____ d. $\frac{27}{10}$ = ____

5. $\frac{1}{6}$'s rod.

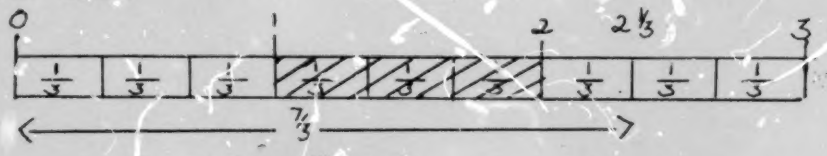
   a. $\frac{11}{6}$ = ____ b. $\frac{17}{6}$ = ____ c. $\frac{7}{6}$ = ____ d. $\frac{18}{6}$ = ____

6. $\frac{1}{12}$'s rod.

   a. $\frac{13}{12}$ = ____ b. $\frac{17}{12}$ = ____ c. $\frac{27}{12}$ = ____ d. $\frac{24}{12}$ = ____

RENAMING MIXED NUMERALS WITH IMPROPER FRACTIONS

To rename $2\frac{1}{3}$ with an improper fraction place the $\frac{1}{3}$'s bar on the fraction track.



The track shows that $2\frac{1}{3} = \frac{7}{3}$.

<u>Exercises</u>: Place the indicated rod on the fraction track. Use it to rename the mixed numeral or whole number with an improper fraction.

1. $\frac{1}{2}$'s rod

   a. $2\frac{1}{2} =$ ____ b. $1\frac{1}{2} =$ ____ c. $2 =$ ____ d. $3 =$ ____

2. $\frac{1}{4}$'s rod

   a. $1\frac{1}{4} =$ ____ b. $1\frac{3}{4} =$ ____ c. $2\frac{3}{4} =$ ____ d. $2\frac{1}{4} =$ ____

3. $\frac{1}{10}$'s rod

   a. $1\frac{7}{10} =$ ____ b. $2\frac{9}{10} =$ ____ c. $2 =$ ____ d. $2\frac{4}{10} =$ ____

4. $\frac{1}{8}$'s rod

   a. $1\frac{5}{8} =$ ____ b. $2\frac{1}{8} =$ ____ c. $1\frac{1}{8} =$ ____ d. $2\frac{7}{8} =$ ____

MULTIPLICATION OF FRACTIONAL NUMBERS SQUARES

Materials: Xerox patterns and

(a) Thermofax transparencies

or

(b) Acetate and fine point permanent marking pen

Directions for making:

(a) Thermofax transparencies. Run transparencies through thermofax machine using the Xerox pattern provided as the last page of these directions.

(b) Acetate. Mark off 3" x 3" squares on the acetate with a permanent marker, for example, a "Sharpie" pen. Then use the Xerox patterns to divide the squares into sections.

You can make 4 sets of squares on 1 foot of 20" wide acetate.

Teaching Procedures:

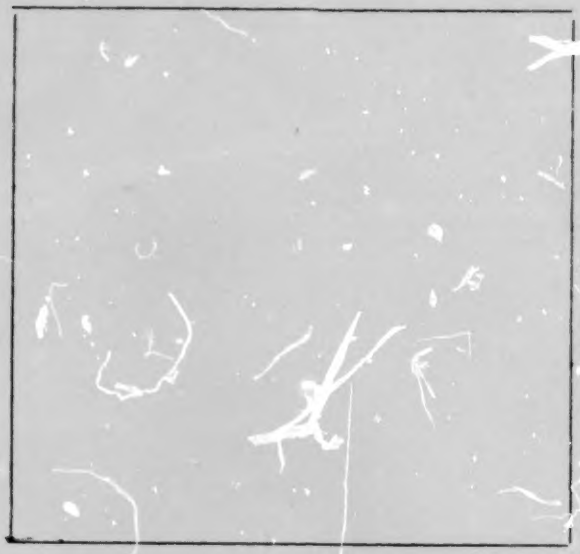
The squares may be used to introduce multiplication of any pair of fractional numbers, each factor less than 1.

When using an oak tag square with a transparency square to model multiplication of fractional numbers, the students must be aware that the two square regions represent the same whole.

See the sample exercises for specific activities and procedures.

The squares may also be used with textbook exercises (as well as teacher developed exercises). With textbook exercises, the squares should be used in the same manner as directed in the sample exercises.

MULTIPLICATION OF FRACTIONAL NUMBERS



WORK AREA

1. Color $\frac{1}{4}$ of the fourths square. Put it on the WORK AREA with the lines this way: ↕

   Place the thirds square on top of the fourths square with the lines this way. ↔

   Point out the part of the picture that shows $\frac{1}{3}$ of $\frac{1}{4}$ of the square.

   $\frac{1}{3}$ of $\frac{1}{4}$ is what part of the square? _____

   $\frac{1}{3}$ of $\frac{1}{4} = \frac{1}{3} \times \frac{1}{4} =$ _____

2. Leave the fourths square on the WORK AREA. Place the other plastic squares on top of the fourths square to show the product.

   a. Sixths square: $\frac{1}{6}$ of $\frac{1}{4} = \frac{1}{6} \times \frac{1}{4} =$ _____

   b. Halves square: $\frac{1}{2}$ of $\frac{1}{4} = \frac{1}{2} \times \frac{1}{4} =$ _____

   c. Eighths square $\frac{1}{8}$ of $\frac{1}{4} = \frac{1}{8} \times \frac{1}{4} =$ _____

   d. Tenths square: $\frac{1}{10}$ of $\frac{1}{4} = \frac{1}{10} \times \frac{1}{4} =$ _____

3. On the sixth square, color $\frac{1}{8}$ and place it on the work area with the lines this way. ↕

Then use your other squares to name the products.

a. $\frac{1}{3} \times \frac{1}{8} =$ _____ b. $\frac{1}{2} \times \frac{1}{6} =$ _____

c. $\frac{1}{8} \times \frac{1}{6} =$ _____ d. $\frac{1}{10} \times \frac{1}{6} =$ _____

4. Color $\frac{1}{3}$ of the thirds square. Put it on the WORK AREA with the lines this way: ↕

Use your other squares to name the products.

a. $\frac{1}{2} \times \frac{1}{3} =$ ____ b. $\frac{1}{8} \times \frac{1}{3} =$ ____ c. $\frac{1}{6} \times \frac{1}{3} =$ ____

d. $\frac{1}{4} \times \frac{1}{3} =$ ____ e. $\frac{1}{10} \times \frac{1}{3} =$ ____

ETC.

<u>Multiplication of Fractional Numbers, Numerators 1.</u>

1. Color $\frac{3}{4}$ of the fourths square. Put it on the WORK AREA with the lines this way: ↕

Place the thirds square on top of the fourths square with the lines this way: ⟷

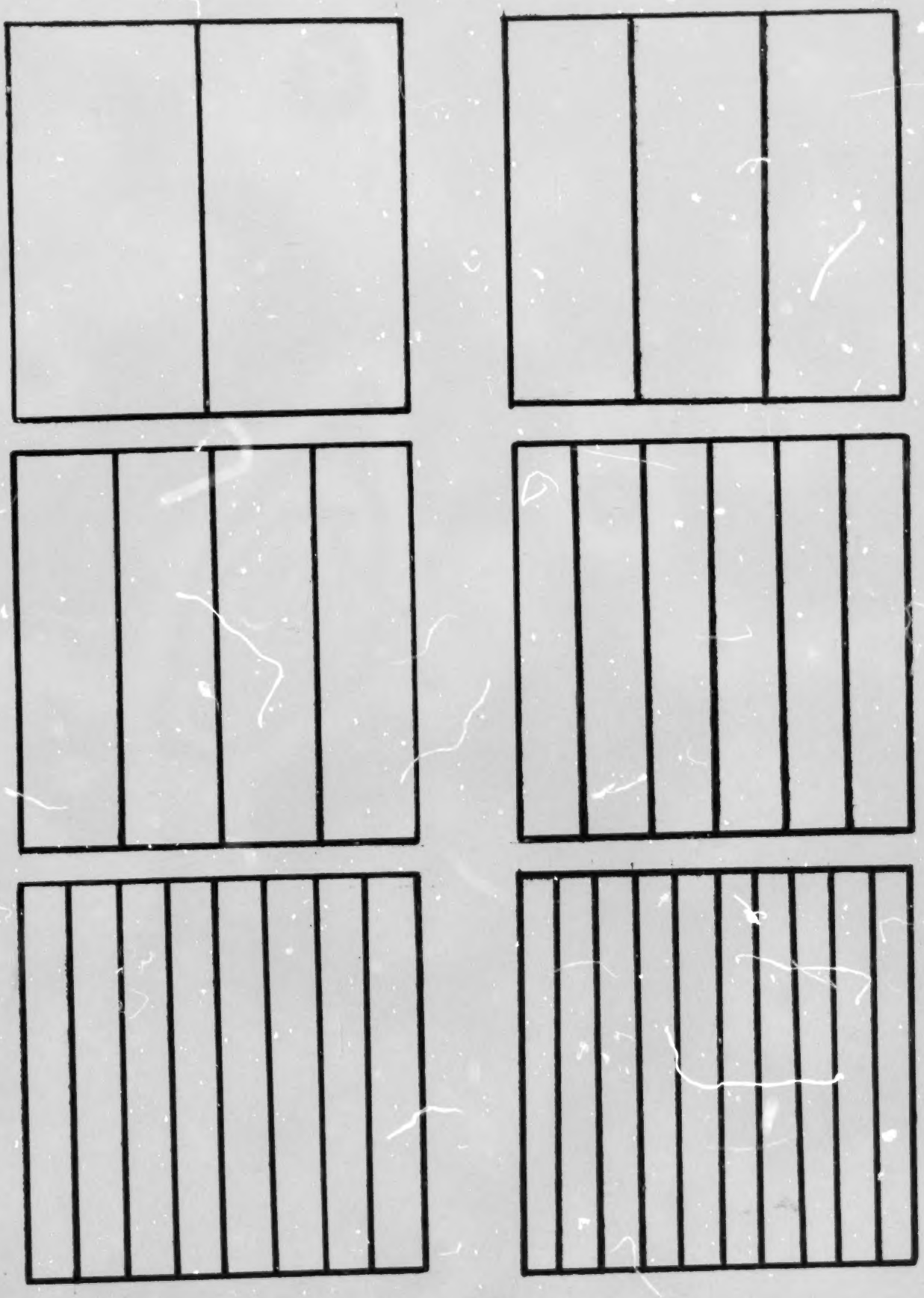
Point out the part of the picture that shows $\frac{2}{3}$ of $\frac{3}{4}$ of the square.

$\frac{2}{3}$ of $\frac{3}{4}$ is what part of the square: _____

$\frac{2}{3}$ of $\frac{3}{4} = \frac{2}{3} \times \frac{3}{4} =$ _____

2. Leave the fourths square on the WORK AREA. Place the other plastic squares on top of the fourths square to show the product.

a. Sixth square: $\frac{5}{6}$ of $\frac{3}{4} = \frac{5}{6} \times \frac{3}{4} =$ _____

b. Eighths square: $\frac{3}{8}$ of $\frac{3}{4} = \frac{3}{8} \times \frac{3}{4} =$ _____

c. Tenths square: $\frac{7}{10}$ of $\frac{3}{4} = \frac{7}{10} \times \frac{3}{4} =$ _____